

PNEUMATIC ASSEMBLY FOR A PAINTBALL GUN

This application is a continuation of copending U.S. Patent Application Serial No. 10/114,915, filed April 1, 2002, which claims priority from U.S. Provisional Patent
5 Application Serial No. 60/302,821, filed July 3, 2001, the contents of which are hereby incorporated herein by reference in their entirety.

BACKGROUND OF THE INVENTION

This invention relates generally to pneumatic launching devices. More specifically,
10 however, this invention relates primarily to pneumatic paintball guns (or "markers") for use in the sport of paintball.

In the sport of paintball, it is generally desirable to have a gun that is as light and maneuverable as possible. Players need increased mobility to move from bunker to bunker quickly to avoid being hit. Furthermore, in the sport of paintball, the marker is treated as an
15 extension of the body such that a hit to the marker counts as a hit to the player. It is desirable, therefore, to have a paintball gun with as small a profile as possible.

SUMMARY OF THE INVENTION

In one embodiment, an in-line pneumatic assembly for a pneumatic launching device
20 (such as a paintball gun) preferably includes a gas storage area, a valve, and a bolt. The gas storage area can be configured to receive compressed gas from a regulated gas supply through a port in the valve. The valve can include two surfaces of different cross-sectional areas. A first surface, having a smaller cross-sectional area, receives a substantially constant supply of compressed gas. A second surface, having a larger cross-sectional area, selectively receives
25 compressed gas to actuate the valve. The bolt can be configured to slide back and forth between a forward and a rearward position. The bolt is preferably arranged in a forward (closed) position before the valve is actuated to fire the gun. When the valve is actuated, compressed gas from the compressed gas storage area is directed through the bolt to launch a paintball.

According to another embodiment, a paintball gun preferably includes a body having a
30 breech. An in-line assembly preferably includes a compressed gas storage area, a valve, and a bolt. The valve is preferably configured to close using a force differential between opposing surfaces of the valve. The bolt is preferably configured to move to a closed position in the

breech before the valve is actuated. The paintball gun also preferably includes a control valve configured to control actuation of the valve in response to a trigger pull.

Other benefits can be achieved by providing electro-pneumatic control of the paintball gun. A control valve, for instance, can be an electro-pneumatic valve (such as a solenoid valve) configured to be operated based on electronic signals from a circuit board. The circuit board can be configured to initiate a firing sequence based on a trigger pull. Still further benefits can be achieved by having a closed-bolt gun that seats the paintball within the breech before releasing the compressed gas to launch the paintball.

According to a further embodiment, a pneumatic paintball gun preferably includes a bolt configured to operate as at least a portion of the firing valve. Most preferably, the bolt includes gas entry ports formed through a lateral bolt wall at a predetermined position along the bolt. The entry ports are preferably configured such that when the bolt reaches a forward position, the entry ports expose an internal bolt chamber to compressed gas from a compressed gas storage area, permitting the compressed gas from the storage area to flow through the bolt and out a forward exit port to launch a paintball.

In one specific embodiment, the bolt is slidably mounted on a valve stem. The valve stem preferably includes a sealing member (such as an O-ring, plug, or any other sealing structure) arranged at its forward end. The sealing member preferably prevents compressed gas from the compressed gas storage area from entering the bolt until the bolt reaches a predetermined forward position. As the bolt approaches the predetermined forward position, the entry ports preferably slide past the sealing member and expose an interior bolt chamber to compressed gas from the storage chamber. Compressed gas therefore passes from the compressed gas storage chamber through the bolt to launch a paintball.

In one of many possible alternative embodiments, a sealing member is arranged in communication with an external surface of the bolt. The sealing member prevents compressed gas from a compressed gas source from entering the bolt until the bolt reaches a predetermined forward position. As the bolt approaches the predetermined forward position, the gas entry ports preferably slide past the sealing member and permit compressed gas to enter the bolt and flow into communication with a paintball, thereby launching the paintball from the marker.

In a most preferred embodiment, the bolt is moved between a rearward and forward position using an electronic solenoid valve. In one configuration, the bolt preferably includes two, oppositely arranged surface areas. The solenoid valve is preferably configured to

alternately supply compressed gas to and vent compressed gas from the two surface areas. More particularly, compressed gas is preferably supplied from the solenoid valve to a forward surface area and vented from a rearward surface area to move the bolt to a rearward position. The compressed gas is preferably supplied to the rearward surface area and vented from the forward surface area to move the bolt to a forward position. Various types, numbers, and configurations of solenoid valves can be used to shuttle the bolt between a forward and rearward position.

In one alternative embodiment, for instance, a constant supply of compressed gas can be directed to one end of the bolt, with compressed gas being selectively supplied through the solenoid valve to an opposite end of the bolt (having a larger surface area) to operate the bolt.

Various other embodiments and configurations are also possible without departing from the principles of the invention disclosed with reference to the foregoing aspects and embodiments. This invention is not limited to any particular embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing objects, features, and advantages of the present invention will become more readily apparent from the following detailed description of preferred embodiments thereof, made with reference to the accompanying figures, in which:

FIG. 1 is a cross-sectional side view of an in-line pneumatic assembly according to one aspect of the present invention;

FIG. 2 is a cross-sectional perspective view of the in-line pneumatic assembly of FIG. 1;

FIG. 3 is a cross-sectional side view of a paintball gun constructed according to another embodiment of the present invention;

FIG. 4 is a cross-sectional perspective view of the paintball gun of FIG. 3.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

The accompanying drawings illustrate the construction of a preferred embodiment of this invention. Referring first to FIGS. 1 and 2, an in-line pneumatic assembly 8 for a paintball gun preferably includes an end cap 12, a valve retainer 14, a firing valve (or valve piston) 16, a compressed gas storage area 20, and a bolt 24 and bolt cylinder 22. The end cap 12, valve retainer 14, compressed gas storage area 20, and bolt cylinder 24 preferably consist of separately molded components that are fitted together end to end to form a contiguous in-line assembly housing. The firing valve 16 is preferably disposed within the end cap 12, valve retainer 14, and compressed gas storage area 20 portions of the in-line assembly housing.

The end cap 12 includes a receiving port 12a arranged to receive a regulated supply of compressed gas. A first end 16a of the valve piston 16 is located within the end cap 12. The valve piston 16 includes a passageway 16b for directing compressed gas from the end cap 12 into the compressed gas storage area 20. An opposite end of the valve piston 16 forms a plug 16c that seats within a releasing port 21a of the compressed gas storage area 20. When seated, the plug 16c prevents the release of compressed gas from the compressed gas storage area 20. The valve piston 16 also includes a first surface area that includes the surface area of the first end 16a of the valve 16 and the surface area at the base of the passageway 16b. A force created by the pressure of the compressed gas on the first surface area tends to keep the valve piston 16 in a closed position, with the plug 16c securely seated in the releasing port.

A valve actuator 18 is located within the valve retainer 14. The valve actuator 18 includes a forward surface 18a having a second surface area that is larger than the first surface area of the valve 16. The second surface area is selectively subjected to compressed gas from a control valve through a port in the valve retainer 14 to actuate the valve 16. The compressed gas supplied to the second surface area preferably has the same pressure as the gas supplied to the first surface area. Because of the difference in cross-sectional areas, however, the force exerted on the second surface area is greater than the force exerted on the first surface area, thereby actuating the valve 16. When actuated, the valve 16 is forced rearward, causing the plug 16c to become unseated from the releasing port 21a of the compressed gas storage area 20. The gas stored in the compressed gas storage area 20 is thereby released into and through the bolt 24.

The bolt 24 is slidably mounted within the bolt cylinder 22 and is capable of movement between a forward and a rearward position. A port 21b in the forward end of the compressed gas storage chamber 20 communicates compressed gas with a rearward surface 24a of the bolt, causing the bolt 24 to rest in the forward position while the gas storage chamber 20 is pressurized. A forward surface 24b of the bolt 24 is preferably configured to selectively receive compressed gas of this same pressure at the time the valve 16 is actuated.

When the valve 16 is actuated, the compressed gas is released from the compressed gas storage area 20, thereby relieving the pressure on the rearward surface 24a of the bolt 24. At this same time, pressure is applied to the front end 24b of the bolt 24. The pressure on the forward end 24b of the bolt 24 therefore causes the bolt 24 to shift to its rearward position. When the valve 16 is deactuated, the plug 16c is again seated in the releasing port 21a of the gas

storage chamber 20, and the pressure therein is allowed to rebuild. The gas applied to the front 24b of the bolt 24 is vented at the same time. The pressure applied to the rearward end 24a of the bolt 24 therefore causes the bolt 24 to shift forward.

Referring now to FIGS. 3 and 4, a paintball gun 7 constructed according to another
5 aspect of this invention includes a housing (or body) 9 having a chamber 10 preferably formed longitudinally there through. An in-line assembly 8, such as that described previously, is arranged within the chamber 10 and preferably includes an end cap 12, a valve piston 16, a valve retainer 14, a compressed gas storage area 20, a bolt cylinder 22, and a bolt 24. A
10 receiving port 12a in the end cap 12 is arranged near a rearward end 10a of the bore 10 to receive a regulated supply of compressed gas from a compressed gas source. The end cap 12 further includes a port arranged to supply a portion of this gas to a control valve 30 though a corresponding port 13 in the gun body 9.

In this particular embodiment, the control valve 30 is an electro-pneumatic four-way solenoid valve (such as that available from the Parker Hannifin Corporation) with one of the
15 output ports plugged. The other output port 34 is selectively pressurized or vented, as desired. When pressurized, the output port 34 receives compressed gas from the input port 32. A three-way solenoid valve or other control valve could also be used.

A rearward end 16a of the valve piston 16 is located within the end cap 12 and receives compressed gas there from. The valve piston 16 contains a passageway 16b that selectively
20 directs compressed gas from the end cap 12 into the compressed gas storage area 20 through ports 17 in the valve piston 16. A valve actuator 18 of the valve piston 16 is moveably retained in a valve retainer 14. The valve piston 16 is capable of longitudinal sliding movement between a forward and a rearward position. In the forward position, the forward end (the plug) 16c of the valve piston 16 is seated within a releasing port 21a of the compressed gas storage area 20. The
25 gas storage area 20 receives compressed gas through the valve piston 16 when the plug 16c is in its seated position. When the valve is actuated, however, the ports 17 of the valve 16 are withdrawn into the valve retainer 14 and the flow of compressed gas from the end cap 12 to the storage area 20 is substantially cut off. Furthermore, when the valve is actuated, the plug 16c releases the compressed gas from the storage area 20 through the gas release port 21a.

30 Ports 14a, 14b are arranged through the valve retainer 14 on each side of the valve actuator 18. The port 14a on the rearward end of the actuator 18 vents gas to ambient pressure.

The port 14b on the forward side of the actuator 18, on the other hand, communicates with the output port 34 of the control valve 30 to selectively receive or vent pressurized gas.

Compressed gas from the compressed gas storage area 20 is directed into a bolt cylinder 22 through a port 21b formed through a forward end 20a of the gas storage area 20. A bolt 24 is retained within the bolt cylinder 22 and is capable of movement between an open position, in which loading of a paintball is permitted, and a closed position, in which loading is prevented. A port 25 arranged near the forward end of the bolt cylinder 22 communicates with an output port 34 of the electro-pneumatic valve 30 to receive or vent pressurized gas.

The operation of this embodiment of the invention will now be described with reference to FIGS. 3 and 4. When compressed gas is supplied to the gun 7 through the end cap 12, it contacts the first surface of the valve piston 16 and drives the valve piston 16 into a closed position. The valve plug 16c is thereby seated within the gas releasing port 21a of the compressed gas storage area 20. A portion of the compressed gas supplied to the end cap 12 is directed through port 13 to an input port 32 of the electro-pneumatic valve 30. Compressed gas is also directed through the passageway 16b in the center of the valve piston 16 to the compressed gas storage area 20. Compressed gas from the compressed gas storage area 20 then travels through the port 21b at the forward end 20a of the storage area 20 into the rearward portion of the bolt cylinder 22. The compressed gas in the rearward portion of the bolt cylinder 22 contacts the rearward surface 24a of the bolt 24 and drives the bolt 24 forward into its closed position. A paintball is thus loaded into the breech 10b and the paintball gun 7 is ready to be fired.

When the trigger 42 is pulled, it contacts and actuates a microswitch 52 that transmits an electronic signal to a circuit board 50. The circuit board 50 then sends a pulse (or a series of pulses, depending on the firing mode) to actuate the electro-pneumatic valve 30. When actuated, the electro-pneumatic valve 30 directs compressed gas to the forward end 18a of the valve actuator 18. Because the second surface area of the valve actuator 18 is greater than the first surface area of the valve piston 16, the valve opens, unseating the plug 16c from the gas releasing port 21a of the compressed gas storage area 20. At the same time, the ports 17 through the valve piston 16 are pulled into the valve retainer 14 to preferably reduce or substantially cut off the flow of compressed gas into the compressed gas storage area 20. The compressed gas within the gas storage area 20 is released through the gas releasing port 21a,

through the bolt 24, into the breech 10b and into contact with the paintball, thereby launching the paintball.

The forward end of the bolt cylinder 22 also receives compressed gas from the electro-pneumatic valve 30 when actuated. When the electro-pneumatic valve 30 is actuated, the compressed gas in the storage chamber 20 is released, relieving the pressure from the back surface 24a of the bolt 24. At the same time, pressure is applied to the front surface 24b of the bolt 24, driving the bolt 24 rearwards into its open position. In this position, another paintball is permitted to load into the breech 10b of the gun. At the end of the electronic pulse, the electro-pneumatic valve 30 is de-actuated, causing the port 14b in front of the valve actuator 18 and the port 25 in front of the bolt 24 to vent the pressurized gas from their respective areas to ambient. As this happens, the force on the valve actuator 18 decreases below that applied to the first surface area of the valve piston 16, causing the valve to close. The gas storage area 20 therefore repressurizes, further directing pressurized gas to the rearward portion 24a of the bolt 24, and causing the bolt 24 to close.

In an alternative construction, the forward end 24b of the bolt 24 could be configured having a surface area smaller than that of the rearward end 24a thereof. In this arrangement, gas of a selected pressure could be constantly supplied to the forward end 24b of the bolt. Gas applied to the rearward end 24a of the bolt 24 from the compressed gas storage area would also be at the selected pressure. In this configuration, as the compressed gas storage area 20 releases gas, the pressure in the storage area 20 and, hence, in the rearward portion of the bolt cylinder 22 drops. The constant pressure applied to the front end of the bolt cylinder 22 thereby forces the bolt 24 rearward, allowing a paintball to seat within the breech 10b of the marker.

At the end of the electronic pulse, the electro-pneumatic valve 30 is de-actuated, causing the port 14b in front of the valve actuator 18 to vent the pressurized gas to ambient. As this happens, the force on the rearward surface areas of the valve piston 16 increases above that on the forward surface 18a of the valve actuator 18, causing the valve 16 to close and the compressed gas storage area 20 to repressurize. When the gas storage area 20 repressurizes, gas is again communicated to the rearward portion 24a of the bolt 24. Because of the area differential between the rearward and forward bolt surfaces, the force of the compressed gas on the rearward portion 24a of the bolt 24 is greater than the force of compressed gas on the forward portion 24b of the bolt 24, causing the bolt 24 to return to its closed position. The marker 7 is then ready for a subsequent firing sequence.

As an additional benefit to the foregoing design, the ram and the bolt of this embodiment can be formed in the same longitudinal assembly. Conventional electronic guns have had separate ram and bolt assemblies, requiring substantially more space in the paintball gun. This design provides the ability to reduce the overall gun size to about half the size, or
5 less, of conventional electro-pneumatic markers.

Having described and illustrated the principles of the invention through the descriptions of various preferred embodiments thereof, it will be readily apparent to those skilled in the art that the invention can be modified in arrangement and detail without departing from such principles. The claims should be interpreted to cover all such variations and modifications.

10